

## Ecological impacts of feral pigs (*Sus scrofa*) on freshwater ecosystems in tropical Australia

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### Abstract

A range of ecological indicators found in northern Australian tropical freshwater habitats were used to quantify feral pig impacts on elements of biodiversity. These indicators were measured for two years in both unprotected ephemeral freshwater lagoons and those protected by fencing from pig impact. The sequential measurements of these ecological indicators as the lagoons drew down gave a guide to the consequences of feral pig impacts on biodiversity. Overall, feral pig activity had a negative impact on the ecological condition of the ephemeral lagoons studied with the major impacts related to destruction of macrophytes and a reduction in water clarity. The visual differences in the proportion of aquatic macrophytes between protected and unprotected lagoons were dramatic; protected lagoons had significantly more macrophyte coverage. The upheaval of wetland sediments in unprotected wetlands significantly reduced the water clarity and had subsequent effects upon key water quality parameters such as dissolved oxygen availability. Other water quality parameters such as nutrients were also strongly affected by pig activity contributing to an increase in nutrient levels in the unprotected lagoons. We have demonstrated that feral pigs do have significant impacts upon wetlands in the tropical environments we studied. However, we have also demonstrated that there are significant natural disturbances also operating in these ecosystems that should be taken into account when assessing impacts to wetlands.

Keywords: ecological impact, freshwater biodiversity, *Sus scrofa*

### Introduction

In Australia, the community general perception is that feral pigs are doing substantial ecological damage and pose a threat to ecological values of many regional ecosystems. There is a distinct lack of information in relation to the dry tropics seasonal freshwater habitats. A number of rare or endangered species and ecosystems regarded as threatened or suspected of being threatened by feral pig impacts occur in the dry tropics and in particular the tropical freshwater ecosystems. A range of ecological indicators found in freshwater habitats was used to quantify feral pig impacts on elements of biodiversity. These indicators were measured for two years in both unprotected ephemeral freshwater lagoons and those from which pig impact was excluded. The sequential measurements of these ecological indicators as the lagoons drew down gave a guide to the consequences of feral pig impacts on biodiversity.

### Materials and methods

This study was conducted in Lakefield National Park in the tropical savannas area of northern Australia, an area of high conservation values. Lakefield is renowned for its vast river systems and spectacular wetlands. In the wet season rivers and their tributaries join to flood vast areas. During the dry season, rivers and creeks leave large permanent waterholes, lakes and lagoons which attract a diversity of animals, particularly waterbirds. Large populations of feral pigs also inhabit this high value freshwater ecosystem; population densities of 4.3 pigs/km<sup>2</sup> have been calculated for this study site.

This study consisted of 'paired' lagoons containing a wide array of submerged, emergent and floating aquatic plants at each of four locations. At each location, one lagoon was enclosed by a pig-proof fence; the associated lagoon was fenced with a 4 plain wire fence to exclude feral cattle. Water quality was sampled over two years at approximate two month intervals. A multi probe was used to record water quality parameters at 30-min intervals for a 24-h period. Proximal lagoons were measured in tandem. Water was sampled for total and dissolved components of nitrogen and phosphorus, ammonia and turbidity. Between four and six permanent transects at 15-25 m intervals in each lagoon were used to measure species composition and abundance of emergent and submersed macrophytes. Sampling for aquatic invertebrates and freshwater fishes was also conducted.

## Results

Pig disturbance created an obvious disturbance of the lagoons. The entire substrate around the margin of all unfenced lagoons was turned over as a result of pig rooting activities. This pig rooting resulted in progressively decreasing aquatic plant cover and increasing amounts of open water and bare ground. There was a significant interaction between fencing treatment and time ( $F_{2,12} = 0.66$ ,  $p = 0.002$ ). This was due to a significant decrease in macrophyte coverage over time in the unfenced, but not fenced treatments. Although water clarity also naturally declines over the course of the dry season, this effect was further exacerbated as a result of pig disturbance. This loss of aquatic plant cover and decline in water clarity were the strongest effects detected in this study. Nutrient concentrations did increase over the course of the season as would be expected with decline in water level but the effects of pigs greatly increased the nutrient levels beyond their natural increase. Dissolved oxygen conditions progressively deteriorated over the course of the season but this affect was heightened in unfenced lagoons compared to fenced lagoons. Pig disturbance is implicated in negatively impacting dissolved oxygen availability and increasing harmful ammonia, nutrient and turbidity levels. No effect of pig rooting was observed on macroinvertebrate or fish species composition and abundance.

## Discussion

This study demonstrates that the foraging activities of feral pigs in these floodplain lagoons disrupt physical, chemical and biological environments. Pig-mediated disturbance in the unfenced lagoons significantly affected water clarity by dramatically increasing turbidity. The degree to which this may have altered primary productivity is unknown, however we have clearly linked pig foraging to the destruction of aquatic macrophytes, and the proliferation of bare ground and open (but turbid) water in these lagoons. Feral pigs pose a serious ecological and economic threat in many parts of the world, including Australia. We argue, however, that their true ecological effects might be best measured in a landscape-specific framework because their effects probably depend on the biology and disturbance history of the affected community and pigs are problematic in a very wide variety of wetlands across Australia.

We have demonstrated that feral pigs do have significant impacts on the water health of wetlands in these tropical wetland environments. Macrophyte populations and water clarity/nutrients are strongly influenced by pig foraging. We have also demonstrated that the level of impacts is also related to the pig population abundance.